IMPACT OF SEAWINDS SCATTEROMETER DATA ON OCEAN SURFACE ANALYSIS AND WEATHER PREDICTION

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I. INTRODUCTION

Scatterometer observations of the ocean surface wind speed and direction improve the depiction and prediction of storms at sea. These data are especially valuable where observations are otherwise sparse—mostly in the Southern Hemisphere and tropics, but also on occasion in the North Atlantic and North Pacific.

The SeaWinds scatterometer on the QuikScat satellite was launched in June 1999 and it represents a dramatic departure in design from the other scatterometer instruments launched during the past decade (ERS-1,2 and NSCAT). More details on the SeaWinds instrument can be found in [1] and [2]. At the time of this writing, SeaWinds scatterometer data from the ADEOS 2 satellite are not yet available . Therefore this paper will be limited to results from the SeaWinds scatterometer on Quikscat. This presentation shows the influence of QuikScat data in data assimilation systems both from the NASA Data Assimilation Office (GEOS-3) and from NCEP (GDAS).

II. SEAWINDS EXPERIMENTS

The strategy for assessing the impact of SeaWinds in NWP was largely described in [2], and parallels the approach used in [3] for the geophysical validation of NSCAT data. Given here are two tables that summarize the early experiments run using data assimilation systems from both the Data Assimilation Office (DAO; Table 1) and the National Centers for Environmental Prediction (NCEP; Table 2) using early data from SeaWinds.

III. ANALYSIS RESULTS

Figs 1-4 show the short-term impact of SeaWinds data on the GEOS data assimilation system. These results are taken from runs that employed an updated model function (time period: 12-27 January, 2000). While the 6 h wind vector and sea level pressure impacts are localized to the satellite swaths, the assimilation system spreads the wind information considerably in the vertical (Fig. 4). After 18 h from the initial time, the vector differences are spread over all the oceans.

TABLE 1

EARLY SEAWINDS EXPERIMENTS: GEOS

- GEOS DATA ASSIMILATIONS USED
  GEOS-1, GEOS-2, GEOS-3
- SPINUP: 10 DAYS
- ASSIMILATION PERIOD
  19 JULY - 19 SEPTEMBER 1999
- EXPERIMENTS
  - CONTROL – ALL CONVENTIONAL DATA + TOVS + CTW
  - QUIKSCAT – CONTROL + THINNED QUIKSCAT WIND VECTOR
  - SSMI – CONTROL + SSMI WIND SPEED
  - ERS-2 – CONTROL + ERS-2 WIND VECTORS
  - SPEED – CONTROL + QUIKSCAT WIND SPEED
- FORECASTS 11 FORECASTS FROM EACH

TABLE 2

EARLY SEAWINDS EXPERIMENTS: NCEP

- SPINUP: 10 DAYS
- ASSIMILATION PERIOD
  19 JULY - 12 SEPTEMBER 1999
- EXPERIMENTS
  - CONTROL – ALL CONVENTIONAL DATA + TOVS + CTW
  - QUIKSCAT – CONTROL + THINNED QUIKSCAT WIND VECTORS **(Sweet Spot Only)**
  - NCEP_OP – CONTROL + SSMI + ERS-2
  - NCEP_OP_Q – NCEP_OP + THINNED QUIKSCAT WIND VECTORS **(Sweet Spot Only)**
  - NCEP_OP_A – NCEP_OP + THINNED QUIKSCAT WIND VECTORS **(Full Swath)**
- FORECASTS 10 FORECASTS FROM EACH
- ADDITIONAL EXPERIMENTS: VARIABLE OBSERVATION ERRORS

Fig. 5 gives a detailed view of the influence that SeaWinds data can have on the positioning of a surface low pressure area in an analysis. The sea level analysis used in GEOS is multivariate; thus wind data can directly affect the analysis of sea level pressure.

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14. ABSTRACT

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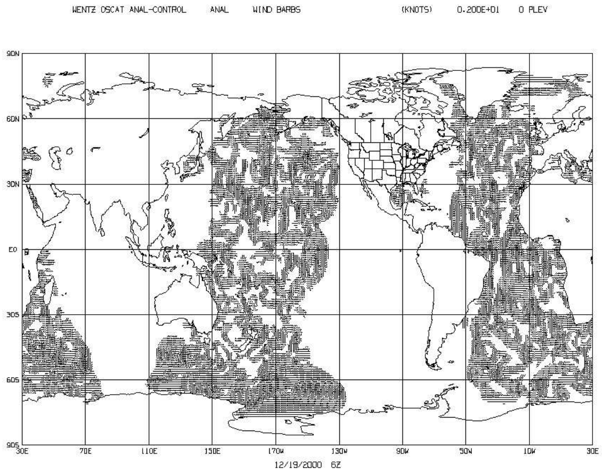

Fig. 1 Impact on ocean surface wind vectors after 6 hours of SeaWinds assimilation. Note residual pattern from the orbits.

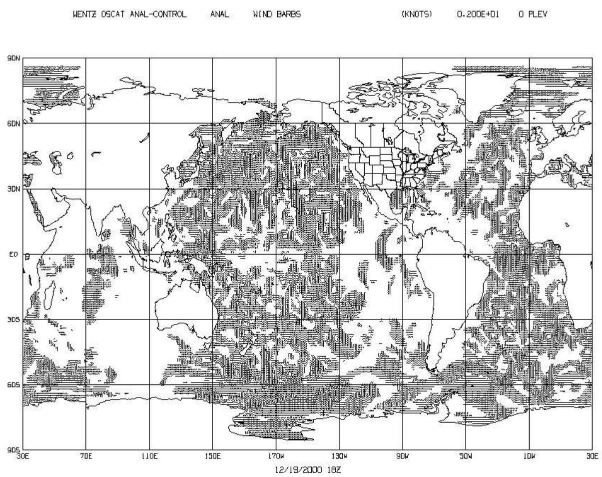

Fig. 2 Impact on ocean surface wind vectors after 18 hours of QuikScat assimilation. Now the difference patterns cover all the oceans over the globe.

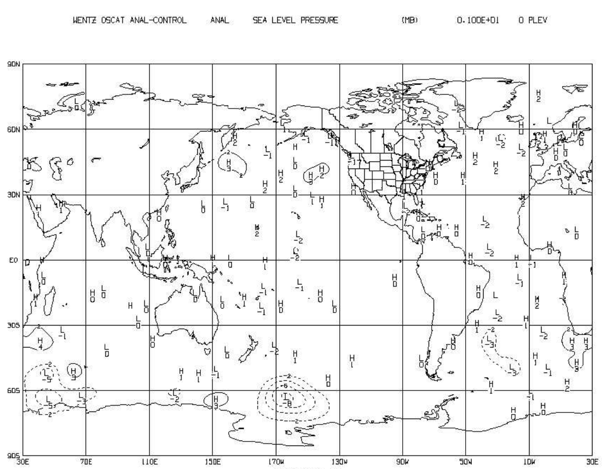

Fig. 3 Differences in Sea Level Pressure Analyses after 6 hours of assimilation.

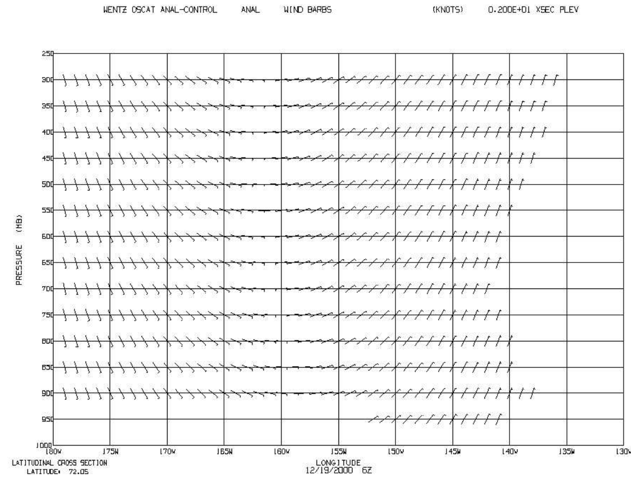

Fig. 4 Vertical cross-section of vector wind differences, showing vertical influence of QuikScat data during the assimilation process.

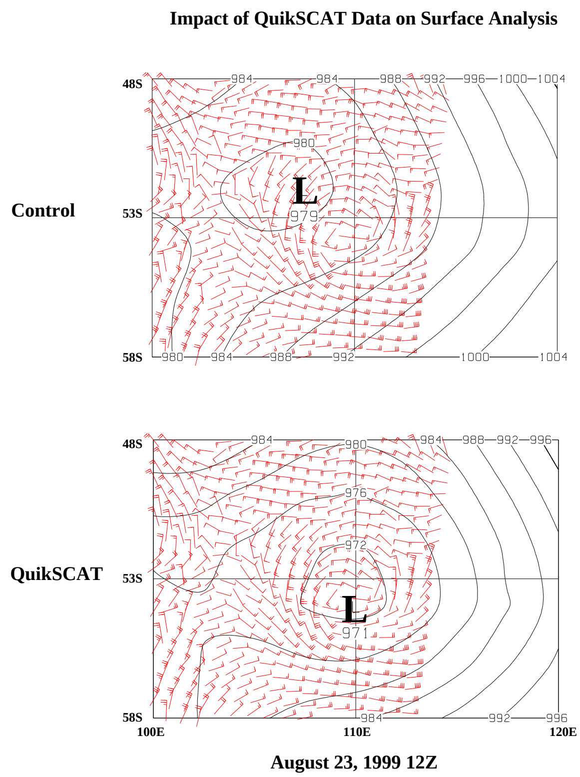

Fig. 5 Top: Control Sea Level Pressure analysis, which does not conform to the QuikScat wind data. Bottom: Sea Level Pressure analysis using QuikScat data, showing a much improved agreement.

IV. FORECAST IMPACTS

A limited sample of 5-day forecasts were made from initial conditions taken from assimilations made with and without SeaWinds data during the period 12-27 January, 2000. Fig. 6 shows the impact these data made on 500 hPa geopotential height anomaly correlations of forecast skill. There was a slight positive impact on forecast skill in the Northern Hemisphere, and there was a somewhat larger improvement in forecast skill in the Southern Hemisphere.

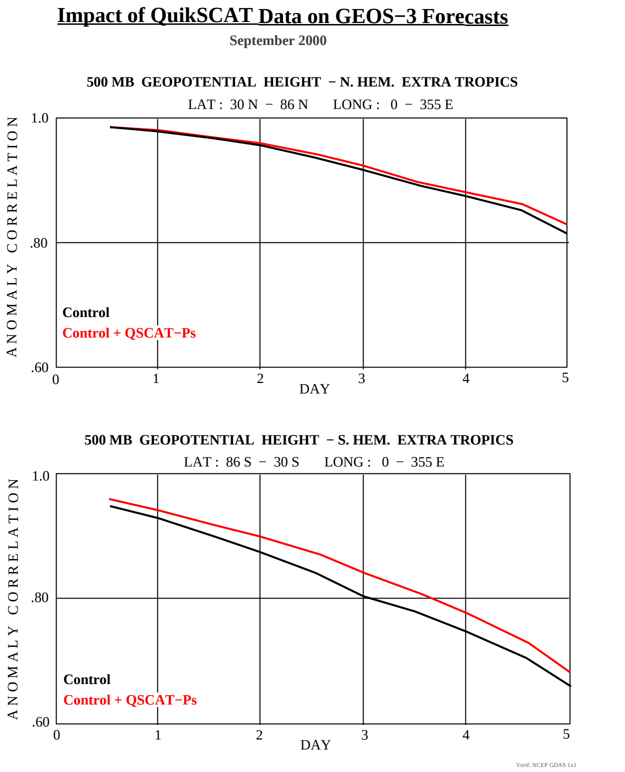

Fig. 6 Anomaly correlation measures of forecast skill. QSCAT-Ps refers to the Sweet-Spot swath subset of SeaWinds data using a newer model function ("prime").

V. HURRICANE CINDY CASE STUDY

The impact of QuikScat data have also been examined in a version of the NCEP operational environment. Fig. 7 shows SeaWinds data having an enormous beneficial influence on the amplitude and positioning of a mid-Atlantic hurricane in a 60 hour forecast.

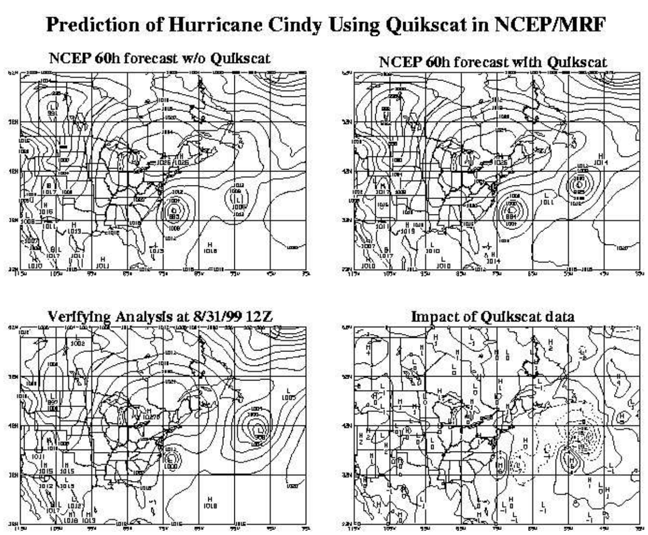

Fig. 7 Impact of QuikScat data in a test version of the NCEP operational environment. Verifying analysis is the lower left panel. Note the greatly improved position and depth of the mid- Atlantic storm. The magnitude of the impact is shown in the lower right panel.

Fig. 8 shows the magnitude and position errors of the mid-Atlantic storm shown at 60 h in Fig. 7 – Hurricane Cindy. This experiment shows that the assimilation of QuikScat data results in a substantial reduction of both magnitude and displacement errors with respect to the control run. The 60 h forecast with QuikScat data is more accurate than the 24 h forecast without QuikScat data. It should be noted, however, that the current NCEP operational system includes ATOVS data which were not used in the experiment described here. As a result, the expected impact of QuikScat data in the current operational system would be smaller.

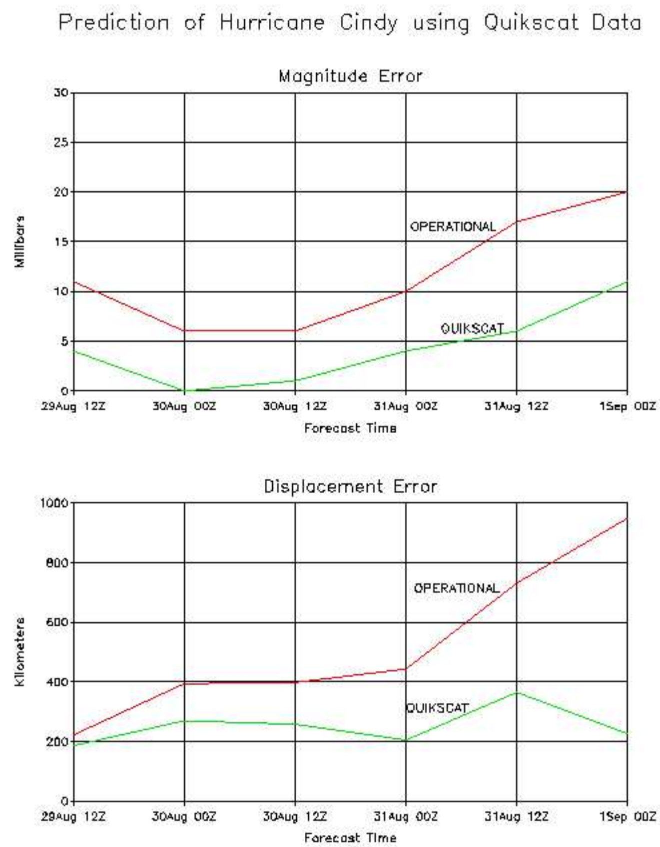

Fig. 8 Magnitude and displacement errors of Hurricane Cindy in the NCEP system over a 60 hour period.

VI. PLANNED SEAWINDS EXPERIMENTS

- NEW DAS CONFIGURATIONS
  – NCEP Regional Data Assimilation System (10 km resolution)
  – fvDAS: Based on Finite Volume (NASA/NCAR) GCM
- NEW DATA SETS FOR ASSIMILATION
  – SeaWinds retrievals generated with improved model functions and quality flags
  – SeaWinds Backscatter

VII. SUMMARY

- SeaWinds (like NSCAT and ERS) shows unequivocal signatures of meteorological features including cyclones, fronts, anticyclones, easterly waves and other precursors of hurricanes and typhoons.
- Through collaborative efforts between NASA and NOAA, National Weather Service marine forecasters are using SeaWinds data to improve analyses, forecasts and significant weather warnings for maritime interests. This results in substantial economic savings as well as the reduction of weather related loss of life at sea.
- The impact of SeaWinds on Numerical Weather Prediction models is on average modest but occasionally results in significant forecast improvements.

The impact of SeaWinds data in Numerical Weather Prediction is currently limited by:

- Data redundancy (the same meteorological information may be detected by multiple components of the overall observing system).
- High accuracy of current atmospheric model first guesses over oceans.
- Super-obbing or thinning of data.
- Occasional difficulties with the quality control of these data.
- Error covariance models used in the data assimilation systems, which directly affect the weight given to the SeaWinds data with respect to a model first guess.
- Physical processes represented in the data that are not resolvable by the assimilation system (representativeness issues).

Improved impact of SeaWinds data would result from:

- Higher accuracy speeds and directions, such as would be achieved by improvements in the retrieval or directional ambiguity removal algorithms.
- More accurate and sensitive quality control of the data during assimilation.
- Improvements to the assimilation system such that more dynamical processes present in the data are resolvable in the assimilation system (for example, higher spatial and temporal resolution for resolving mesoscale processes).
- More general and accurate error covariance models, that would be more reflective of the atmospheric state that the data is sampling.

REFERENCES

[1] R. Atlas, R.N. Hoffman, S.M. Leidner, J. Sienkiewicz, T.-W. Yu, S.C. Bloom, E. Brin, J. Ardizzone, J. Terry, D. Bungato, and J.C. Jusem, "The effects of marine winds from scatterometer data on weather analysis and forecasting," *Bull. Amer. Meteor. Soc.* vol. 82, pp. 1965-1990, 2001.

[2] S.C. Bloom, R. Atlas, E. Brin, J. Ardizzone, "Validation of QuikScat SeaWinds Data at GLA," *Reprint from the 13th Conference on Numerical Weather Prediction, Denver, CO.*, pp. 11-14, 1999.

[3] R. Atlas, S.C. Bloom, R.N. Hoffman, E. Brin, J. Ardizzone, J. Terry, D. Bungato and J.C. Jusem, "Geophysical validation of NSCAT winds using atmospheric data and analyses," *J. Geophys. Res.*, vol. 104(C5), pp. 11405-11424, 1999.